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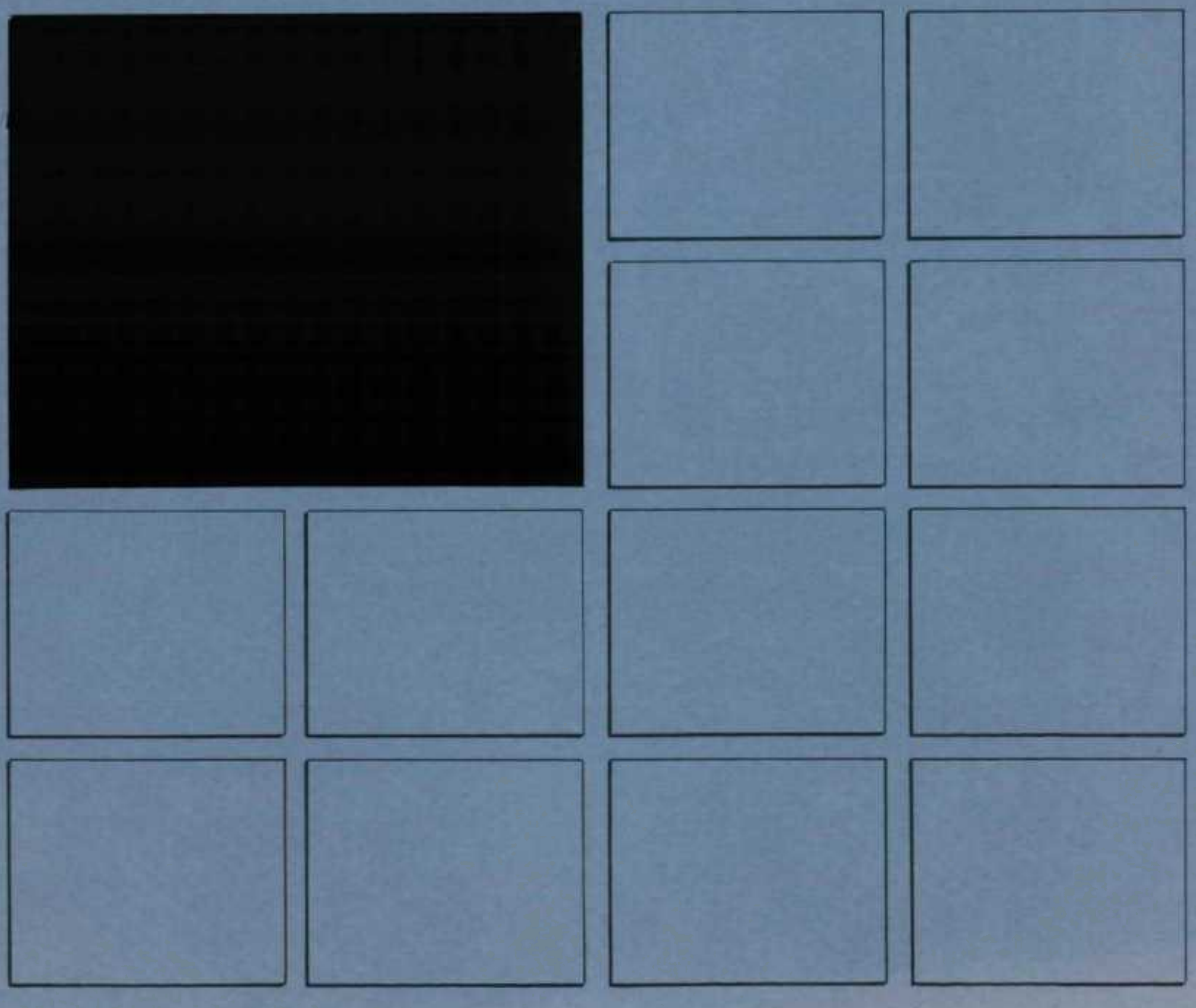

AN INTRODUCTION TO HYDATA

C S Green

Institute of Hydrology
Wallingford
Oxfordshire
U.K.

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Contents

1. Introduction

HYDATA is a hydrological database and analysis system designed for use on modern micro-computers. This note is an introduction to the system. For a full description of its operation refer to the HYDATA Operation Manual.

HYDATA stores, edits, prints, plots and provides some analysis of basic hydrological data. The system is designed for use either in developing countries or for project use where low cost and ease of use are of particular importance. One of the most important design criteria for the system has been the ease of use for the operators. This is particularly important for staff with limited or no experience of computers. This challenge has been met by extensive use of screen menus, adopting an interactive approach throughout and with error checking of each operator response. In order to allow staff to concentrate on the scientific aspects of operation, the system has been designed to be self-contained and to require minimum knowledge of the computer operating system and datafile structure. Both on screen and plotter graphics aid data interpretation.

HYDATA stores and presents data in calendar or hydrological years. The choice of start month is made during the installation of the system.

A primary requirement of any hydrological database system is to produce 'yearbook' type summaries of daily data for publication. In addition HYDATA produces monthly data, graphical output and data in ASCII text form for transfer on floppy disc to other machines.

The database manager, which is transparent to the user, consists of a set of storage and retrieval routines which were originally developed at the Institute of Hydrology for mainframe storage of hydrological data. Among other applications, these routines are used in the U.K. Surface Water Archive system. HYDATA itself has been used in studies in the UK and has been applied in Somalia, Thailand, Fiji, Honduras, Ivory Coast and Lesotho.

HYDATA requires a computer running under MS-DOS or PC-DOS with a hard disc system, 512k byte memory and an EPSON compatible printer. Although not essential, enhanced colour graphics are strongly recommended on any machine. In addition a pen plotter (Hewlett Packard 7475A or similar) is necessary for quality hard copy of graphical output.

The system has run successfully on the following machines :

IBM-PC/AT
Olivetti M24-SP
Compaq Portable II
Compaq Deskpro 286
Opus II
Amstrad 1512 (under MS-DOS)
Tandon PCA series

The system is written in FORTRAN which will aid portability to different machines in the future and provides relatively fast execution speeds. A FORTRAN library is available to enable users to abstract daily data directly for their own analysis or modelling programs.

HYDATA will operate in single colour on a monochrome display or in multiple colour on a colour display.

2. Types of data stored

The system currently supports six types of stations which store the following data :

(a) River stage or lake level (Between 1 and 100 readings/day)
(b) Rating equations and flow gauging data (maximum 332 gaugings & 20 rating equations/station)
(c) Daily flow
(d) Daily rainfall
(e) Daily general (evaporation, catchment rainfall or other)
(f) Daily reservoir storage

Stage or lake level may be stored in a choice of three formats to allow precision, numerical range or flags to be assigned to the data. Flags may be used to indicate source of data such as original, observer, telemetry or logger.

Gauging information comprises date, water level, total cross sectional area, mean velocity and estimated discharge. Rating equations are stored as three parameter and up to three segment logarithmic relationships of the form :

$$Q = a1\ (\ h + c\ )^{b1} \qquad h < h1$$

$$a2\ (\ h + c\ )^{b2} \qquad h2 > h > h1 \text{ (Optional)}$$

$$a3\ (\ h + c\ )^{b3} \qquad h3 > h > h2 \text{ (Optional)}$$

where, Q = discharge m^3s^{-1}
h = stage m
a1,a2,a3,b1,b2,b3,c = parameters

There may be up to 332 discharge measurements and 20 rating equations for each station. Rating equations are date marked and are used within the system to calculate daily mean flow.

Flags may be attached to all types of daily data (Flow, Rainfall, General, Reservoir Storage) to show the source of each data item. For example data may be flagged as original, estimated or modelled. This facility enables the data set to be infilled by modelling or correlation whilst still allowing the original data to be retrieved at a later date when required. A 'General' station may be used to store any data on a daily basis such as evaporation and catchment rainfall.

Comments of up to 32 characters in length may be stored with each month of data for stage, flow, rainfall, general and storage stations. This facility may be removed for any or all station types to save disc space.

Monthly data may be abstracted for any of the daily data stations.

3. Management of data

Stage, flow, rainfall, general and storage data are stored and retrieved in blocks of hydrological years. HYDATA handles all aspects of file storage; the user needs only to specify the station number and the year of data to be abstracted. Rating station information of river gaugings and rating equations are also stored and retrieved automatically by the system.

Security of data is important. Many days, months or even years of work can be lost due to hard disc failure or theft of the computer. HYDATA has its own data backup system which permits any number of copies of datafiles to be made onto floppy discs or a second hard disc. Since datafiles may be large, larger even than the capacity of a single floppy disc, HYDATA splits files where required to ensure files are copied whatever their size. A data restore facility reverses this process and restores the hard disc files from a data backup.

4. General Operation of the system

Entry to the system is protected by password to help safeguard data. Passwords can have one of three levels of authority. The lowest level permits interrogation of data, printing, plotting and transfer to text file. In addition to the above, the second password level allows data to be changed and the results saved on disc. The highest level of password allows all operations including addition of new stations and deletion of data.

The system is operated by a system of screen menus giving the options available at any particular point in the system. For example the plotting menu for daily flow data is as follows :

Plot options - E12

[1]	Quit	
[2]	Start date	[Jan 1]
[3]	End date	[Dec 31]
[4]	Max value	[200.0]
[5]	Min value	[0.0]
[6]	Colour	[Yes]
[7]	A3/A4	[A4]
[8]	Plot edits	[No]
[9]	Draw grid	[Yes]
[10]	Key position	[2]
[11]	Histogram	[No]
[12]	Change more	
[13]	Paper plot	
[14]	Screen plot	

If a plot was required for the month of January only, the operator would first select option [3] and then enter Jan 31. Option [13] or [14] would then be selected depending on whether the plot was required on the pen plotter or on the screen. At every stage the operator response is checked and an informative message given if a mistake is made. In the above example if option [5] was selected and a minimum value of 300.0 entered, the following message would appear :

ERROR Maximum must be greater than minimum

Screen editors are available for all types of data. This facility allows the operator to move quickly through a block of data and undertake additions and corrections easily.

Special keys (function keys) assist with operation and have the following actions :

(1) Return to the computer operating system
(2) Abort previous selection
(3) Read from file
(4) Move cursor in menu selection and screen editors

At any stage input of data or commands may re-directed from the operator to a named file. This facility allows frequently used sequences of commands to be stored in a file or allows data to be transferred from a second computer. HYDATA can also write data into an ordinary text file. The format of the data in this file is the same as the HYDATA input format. This enables data to be transferred between two computers running HYDATA and is useful where the systems are operating in regional offices.

A system summary may be requested at any time to provide a list of stations on the system, the station details such as name, latitude and longitude and period of record.

Station numbers may be from one to eight digits (1 - 99999999). It is possible to have the same station number for different types of station; for example stage station 100, rating station 100 and daily flow station 100 are allowed. Station numbers may be changed later if required.

At present there is a limit of 1000 stations on the system and data is required to come from this century. However these restrictions can be lifted on request.

5. Editing and presenting data

Editors are provided for all types of data stored on the system. The appropriate editor for a particular data type is selected by menu operation as descibed in Section 4. Editors cover a wide range of functions :

(a) Entry and quality control of data
(b) Printout of data
(c) Plotting of data
(d) Conversion of stage to flow (or reservoir storage)
(e) Writing of data to text files
(f) Changing station details such as number, name altitude, etc.

For all but rating data, the operator selects the data to be edited by the station and year. Immediate access is then provided to 12 months of data. Since plotting is available within the editor it is possible to check data entered by plotting a graph before 'saving' the results onto disc. Quality control checks are applied to data as they are entered. Checks are made against preset station maxima and minima and against excessively large jumps between readings. The staff gauge editor also permits conversion of stage to flow (or reservoir volume), either immediately stage data are entered, or at a later date. In addition, if an independent graphics screen is fitted to the system, the stage editor is able to plot data as they are entered in the form of a scrolling hydrograph.

Comments may be stored on a monthly basis for stage, flow, rainfall, general and storage stations.

The rating data editor has access to all discharge measurements and rating equations for the station and has the ability to to develop 3-segment, 3-parameter rating equations for any subset of discharge measurments. Comprehensive facilities are available for investigating shifts in rating and plotting of discharge measurments and rating equations.

Examples of HYDATA printer and plotter output are given below in Section 6.

6. Example printout and plots

Examples of HYDATA print and plot output are given in this section. These do not represent the full range of output available but illustrate some of the possible options.

Printed output is designed to be easily copied onto A4 or quarto sized paper. This is useful if output is required for yearbook presentation or for inclusion in reports.

Plotter output may be produced in single or multi colour. If single colour is selected various dashed lines are used rather than lines of different colour obtained in the multi-colour mode. Although all plots shown are A4 size, A3 plots can also be produced. In fact plots of almost any size can be produced by changing overall scaling factors. This is useful if a small plot is required for inclusion within the text of a report. For plots larger than A3, the system will draw the plot in parts on separate A3 sheets. These may then be joined manually to form the larger plot. Many of the plotting parameters such as axis length and letter size are held in the installation file which may be changed to suit the user's preferred format. Screen graphics are identical to plotter graphics except that screen resolution is normally less than can be achieved on a pen plotter.

The following tables illustrate some of the print options :

Table 1 List of stations and parameters (part of output)

Table 2 File allocation and usage for stage stations

Table 3 Summary of stage data for one year

Table 4 Annual listing of daily mean flow

Table 5 List of discharge measurements and comparison with rating equation (part of output)

Table 6 Rating table (part of output)

Table 7 Monthly summary of daily flows

The following figures illustrate some of the plotting possibilites :

Figure 1 Annual stage hydrograph

Figure 2 Histogram of annual daily flows

Figure 3 and Figure 4 — Discharge measurements plotted on linear and log scales with fitted rating equation. These figures also illustrate the flexibility of the graphics showing two plots on a single page, achieved by movement of plotting origin and adjustment of overall X and Y scaling factors

Figure 5 — Comparison of two annual series of reservoir storage

Figure 6 — Plot of monthly rainfall data

7. Analysis programs

At present the following analysis programs are provided as an addition to the basic HYDATA system :

(a) Double mass plots (on daily data)
(b) Flow duration curves (on daily flow data)
(c) Logarithmic plot to determine slope of hydrograph recession
(d) Baseflow Index (automated hydrograph separation of groundwater component of total flow hydrograph)

All analysis programs are fully compatible with the basic HYDATA system, are menu operated, and offer the same standards of print and plot output. Data for the analysis software is taken directly from the database files. The following figures illustrate some of the graphical output :

Figure 7 — Double mass plot of a rainfall and flow station

Figure 8 — Comparison of three flow duration curves

Figure 9 — Baseflow Index (hydrograph separation)

8. Further information

Contact :

Dr Chris Green or Dr Alan Barr
Institute of Hydrology
Wallingford
Oxfordshire
United Kingdom

Telephone : Wallingford (0491) 38800 Telex : 849365 (HYDROL G)

List of stations & details - Part 1

Type	Number	Name	Basin No.	Latitude	Longitude	Altitude	Area
Stage	1	H-117 - Sovani creek /Nasarowaca	54	16:35:45 S	178:50:15 E	0.0	3.4
Stage	2	H-116 - Vunisea creek @ road brg	55	16:37:10 S	178:49: 0 E	0.0	4.2
Stage	3	H-153 Korotolutolu at Saw Mill	54	16:31:25 S	178:58:40 E	6.0	49.0
Stage	4	H-119 Naselesele Crk at Main Rd	55	16:39: 0 S	178:45:40 E	30.5	29.8
Stage	5	H-070 Namuka Creek at Tabia	53	16:28: 0 S	179:15: 0 E	15.0	25.5
Stage	6	H-038 Qawa river at Bulileka	53	16:26:35 S	179:26:30 E	1.0	38.3
Stage	7	H-101 Saivou creek	54	16:36:10 S	179: 9:10 E	70.0	29.2
Stage	115500	HA - 065 Teidamu below Wainisavu	11	17:34: 4 S	177:32:48 E	0.0	56.0
Stage	115501	HA067 - Vitogo at Vakabul.	11	16:36:14 S	177:31:47 E	0.0	47.5
Stage	126501	HA064 - Varaciva at New Headworks	12	17:35:41 S	177:38:48 E	0.0	17.0
Stage	127500	HA093 - Ba at Toge	12	17:37:30 S	177:44:11 E	0.0	579.0
Stage.	128400	HA162 - Ba at Navala	12	17:39:49 S	177:48:51 E	40.0	322.0
Stage	139600	HA071 - Nasivi at Vatukaula Brdg	13	17:29:35 S	177:52: 5 E	0.0	96.0
Stage	310900	HA163 - Navua at Waibogi	31	18: 7:16 S	177:59:39 E	0.0	462.0
Stage	311801	HA003 - Navua at Nakavu	31	18:11:25 S	178: 6:15 E	0.0	963.0
Stage	311900	HA132 - Wainikavou above Falls	31	18: 6:30 S	179: 3: 5 E	0.0	24.0
Stage	312800	HA004 - Wainikavika at R. Bridge	31	18:11:15 S	178: 9:20 E	0.0	7.5
Stage	356900	HA095 - Tawanua at Balenabelo	35	18: 9: 5 S	177:37:42 E	0.0	61.0
Stage	415401	HA097 - Sabeto at Masisasi	41	17:43:14 S	177:38: 8 E	0.0	71.3
Stage	424200	HA166 - Vatuwa at Vatuwa	42	17:52:19 S	177:27:57 E	125.0	4.5
Stage	424201	HA167 - Masi at Masi	42	17:54: 3 S	177:27:14 E	158.0	4.7
Stage	425200	HA021 - Nawosi at Yavuna	42	17:49:39 S	177:32:28 E	0.0	62.0
Stage	425201	HA100 - Nawaka at Natuaceri	42	17:15:14 S	177:28:18 E	0.0	70.0
Stage	425300	HA020 - Nadi at Votualevu	42	17:46:26 S	177:30:53 E	0.0	164.0
Stage	439401	HA160 - Nukunuku at Lewa	43	17: 0:40 S	177:54:48 E	561.0	18.8
Stage	445000	HA090 - Sigatoka at Namuka	44	18: 2:17 S	177:33:28 E	0.0	1333.0
Stage	454000	HA074 - Tuva at Ecuri	45	18: 3:37 S	177:22:44 E	0.0	208.0
Stage	456001	HA166 - Tuva at Sewa bridge	45	18: 4:44 S	177:22:48 E	3.0	213.7
Stage	526600	HA082 - Bucaisau at Qelesunu	52	16:24:55 S	179:29: 0 E	7.0	80.0
Stage	527601	HA141 - Wainikoro at Nasasa	52	16:23:15 S	179:34:30 E	6.0	46.7
Stage	535600	HA142 - Dawala at Nakorotutari	53	16:32:35 S	179:24:10 E	4.5	93.0
Stage	535601	HA169 - Lovo upstream Matalolo	53	16:34: 3 S	179:25:35 E	0.0	18.0
Stage	535702	HA049 - Wailevu at Nakawa	53	16:29:25 S	179:21: 5 E	5.0	77.0
Stage	540600	HA066 - Nabiti at Nabiti	54	16:36:10 S	178:53:50 E	1.5	31.1
Stage	542601	HA077 - Dreketi at Ford Batiri	54	16:34:40 S	179: 3:25 E	1.5	317.0
Stage	542700	HA055 - Dreketi at Natua Pwp Hse	54	16:31: 0 S	179: 8:45 E	80.0	107.6
Stage	559500	HA-036 - Sarowaqa at Naroga	55	16:41:55 S	178:47:55 E	3.0	99.0
Rating	1	H-117 - Sovani creek/Nasarowaqa	54	16:35:45 S	178:50:15 E	0.0	
Rating	2	H-116 - Vunisea creek @ road brg	55	16:37:10 S	178:49: 0 E	0.0	
Rating	3	H-153 - Korotolutolu	54	16:31:25 S	178:58:40 E	6.0	

Table 1

File allocation & usage for Stage stations

YEAR

Station	1900-09 0123456789	1910-19 0123456789	1920-29 0123456789	1930-39 0123456789	1940-49 0123456789	1950-59 0123456789	1960-69 0123456789	1970-79 0123456789	1980-89 0123456789	1990 - 2000 0123456789 0
1	----------	----------	----------	----------	----------	-ddddddddd	ddddddddd	ddddddddd	ddddddxxx	x--------- -
2	----------	----------	----------	----------	----------	-.........	...ddddxd	ddddxddxx	ddxxddxxx	x--------- -
3	----------	----------	----------	----------	----------	-.........	...ddddxxx	dxddddddd	ddxddd....	.--------- -
6	----------	----------	----------	----------	----------	-.........	....	....	.....ddxxx	x--------- -
7	----------	----------	----------	----------	----------	-.........	....	....	...ddddxxx	x--------- -
10	----------	----------	----------	----------	----------	-ddxddddd	ddddddddd	ddddddddd	ddddddxxx	x--------- -
11	----------	----------	----------	----------	----------	-.........	...ddddddd	ddddxdddd	ddddddxxx	x--------- -
12	----------	----------	----------	----------	----------	-.........	...ddddddd	ddxxddddd	ddddddxxx	x--------- -
14	----------	----------	----------	----------	----------	-.........	...ddddddd	ddddddddd	ddddddxxx	x--------- -
15	----------	----------	----------	----------	----------	-.........	...ddddddx	xdxxxxdddd	ddddddxxx	x--------- -
16	----------	----------	----------	----------	----------	-.........	....	....	.....dxxx	x--------- -
101	----------	----------	----------	----------	----------	-.........	....	....	ddddddxxxx	x--------- -
102	----------	----------	----------	----------	----------	-.........	....	....	ddddddxxx	x--------- -
103	----------	----------	----------	----------	----------	-.........	....	....	xddddxxxx	x--------- -
104	----------	----------	----------	----------	----------	-.........	....	....	ddddddxxxx	x--------- -
105	----------	----------	----------	----------	----------	-.........	....	....	ddddddxxxx	x--------- -

Key :

- = outside project period
. = inside project period
x = space allocated - no data
d = space allocated - data on

Table 2

Summary of stage data

Station number : 10 Name : Shebelli at Beled Weyn

Basin no. : 2 Latitude : 0: 0: 0 N
Longitude : 0: 0: 0 E Altitude : 176.11
Area : 211800. Convert to : Flow
Rating : 10 Store in : 10

Year : 1964

2 Readings @ times :

8:00:00 18:00:00

Monthly & annual maxima & minima

Month	First maximum			First minimum			Days
	Stage	Date	Time	Stage	Date	Time	Missing
Jan	1.130	1	8:00:00	0.770	31	18:00:00	0
Feb	0.760	1	8:00:00	0.420	26	18:00:00	0
Mar	0.410	1	8:00:00	0.200	26	8:00:00	0
Apr	1.310	30	8:00:00	0.180	6	18:00:00	0
May	1.350	1	8:00:00	0.650	30	18:00:00	1
Jun	0.770	15	18:00:00	0.500	11	8:00:00	0
Jul	1.430	29	8:00:00	0.670	1	18:00:00	0
Aug	3.310	31	18:00:00	1.350	3	8:00:00	0
Sep	3.500	30	18:00:00	2.560	10	8:00:00	0
Oct	3.550	2	8:00:00	2.180	16	8:00:00	0
Nov	3.550	3	8:00:00	0.770	30	8:00:00	0
Dec	1.450	31	18:00:00	0.580	12	8:00:00	0
Annual	3.550	2 Oct	8:00:00	0.180	6 Apr	18:00:00	1

Stage readings in metres

Annual summary of daily data - Flow

Station number : 10 Name : Shebelli at Beled Weyn

Basin no. : 2 Latitude : 0: 0: 0 N Longitude : 0: 0: 0 E Altitude : 176.11
Area : 211800.

Year : 1964

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	40.995	24.407	11.759	6.051	51.08	20.125	21.14	57.352	212.83	227.25	221.86	24.243
2	39.626	23.577	11.73	5.921	48.321	19.581	21.538	56.464	215.6	230.61	227.55	24.422
3	38.897	22.759	11.587	5.921	48.175	18.681	23.903	54.132	215.78	230.81	230.52	25.902
4	38.194	21.952	11.402	5.921	45.628	17.392	26.952	54.098	213.67	230.81	228.22	25.8
5	37.903	21.337	11.124	5.812	44.116	16.797	28.332	57.146	204.23	230.53	218.68	24.323
6	37.474	20.763	10.819	5.577	43.901	16.457	27.618	59.414	179.7	225.72	206.0	24.141
7	37.156	20.162	10.518	5.451	40.858	16.241	26.353	62.624	164.98	222.2	177.85	23.347
8	35.03	19.621	10.22	5.451	40.166	15.588	25.037	66.22	150.09	215.73	135.25	21.995
9	35.771	19.031	9.941	5.451	39.918	15.346	24.367	70.038	142.92	203.94	103.66	21.854
10	38.226	18.279	9.78	5.622	36.094	15.033	23.267	73.915	140.36	185.43	87.734	20.506
11	41.341	17.856	9.491	7.381	36.619	14.763	22.742	78.06	141.71	166.96	76.665	19.387
12	40.692	17.229	9.32	14.061	33.775	15.892	22.752	81.158	142.62	146.09	71.719	17.822
13	39.585	16.943	8.949	33.699	31.904	19.075	25.474	84.579	142.71	132.6	66.954	18.358
14	34.236	16.598	8.643	39.463	30.063	23.262	28.607	88.29	143.37	117.79	61.599	18.232
15	36.155	16.082	8.368	41.759	26.735	24.694	29.472	91.512	142.53	111.0	57.71	18.454
16	37.334	15.729	9.22	39.817	24.071	24.978	28.79	96.292	141.1	109.36	53.088	18.449
17	37.408	15.203	8.205	37.402	23.167	24.554	28.535	101.43	141.71	109.81	49.565	18.765
18	37.803	14.4	7.961	36.909	22.56	23.016	30.034	111.89	144.34	110.23	46.452	19.071
19	37.402	14.317	7.588	36.014	22.5	21.392	33.996	120.94	149.16	120.79	43.085	18.938
20	36.684	14.012	7.421	32.386	22.157	20.609	37.911	129.48	152.01	130.92	40.502	18.192
21	35.708	13.696	7.302	30.643	22.119	20.356	42.483	141.28	158.81	137.29	38.009	19.586
22	34.673	13.513	7.161	31.924	22.721	20.188	42.973	149.9	170.11	145.65	35.55	19.969
23	32.703	13.184	7.044	24.419	24.151	20.873	43.725	158.65	177.67	153.98	33.166	19.39
24	32.117	12.858	6.892	22.837	25.499	21.304	45.421	170.11	185.49	158.14	32.116	18.505
25	30.961	12.535	6.638	22.506	25.587	22.07	47.112	177.52	192.86	170.11	30.9	19.182
26	29.663	12.216	6.212	25.345	24.049	23.033	50.711	182.12	203.0	177.52	29.458	27.027
27	28.724	12.044	6.406	33.751	22.613	22.393	53.766	187.9	211.86	182.49	28.435	35.751
28	27.838	12.044	6.406	41.112	21.875	21.574	56.358	193.64	215.86	189.0	27.246	40.204
29	26.964	12.027	6.294	48.909	21.018	21.14	58.391	196.64	220.43	197.99	26.659	47.499
30	26.1		6.162	51.381	20.394	21.107	58.56	202.14	224.38	207.94	25.118	52.521
31	25.248		6.162		20.259e		58.021	206.57		215.58		57.873
Mean	35.11	16.733	8.5719	23.63	31.029	19.91	35.301	114.89	174.73	174.01	90.354	25.152
Maximum	41.341	24.407	11.759	51.381	51.08	24.978	58.56	206.57	224.38	230.81	230.52	57.873
Minimum	25.248	12.027	6.162	5.451	20.259	14.763	21.14	54.098	140.36	109.36	25.118	17.822
R/off mm	0.444	0.19759	0.1084	0.28918	0.39239	0.24366	0.44642	1.4528	2.1383	2.2005	1.1057	0.31807

Flows in cubic metres per second

Annual statistics

Maximum 230.805 Minimum 5.451 Mean 62.538 cubic metres per second

Total 1977.604 million cubic metres Runoff 9.337 millimetres

Possible data flags

Missing - flag "-" Original - no flag set Estimate - flag "e"

Table 4

Printed on 5/ 2/1987

Discharge measurements for station 11 : Shebelli at Bulo Burti

Order Number	Date	Rating	Stage (m)	Velocity (m/s)	Area (sq m)	Discharge (cumecs)	--- Comparison --- Diff./Rat.	Plot
36	23 Jun 1980	B	1.420	0.758	20.59	15.610	-0.07/B	<-
37	29 Jul 1980	B	2.210	0.775	51.17	39.660	-0.01/B	-
38	28 Aug 1980	B	3.340	0.951	93.47	88.890	-0.00/B	-
39	1 Sep 1980	B	3.900	0.970	119.34	115.760	0.04/B	->
40	17 Sep 1980	B	3.290	0.956	91.90	87.860	-0.03/B	<-
41	15 Oct 1980	B	2.620	0.798	65.78	52.490	0.08/B	->
42	18 Nov 1980	B	1.410	0.666	22.85	15.220	-0.06/B	<-
43	20 Nov 1980	B	1.350	0.603	20.63	12.440	-0.01/B	-
44	1 Jan 1981	B	0.920	0.189	13.12	2.480	0.04/B	->
45	3 Jan 1981	B	0.880	0.164	14.09	2.310	0.01/B	-
46	8 Mar 1981	B	0.690	0.242	1.49	0.360	-0.00/B	-
47	10 Mar 1981	B	0.870	0.420	5.48	2.300	0.01/B	-
48	29 Mar 1981	B	4.900	1.090	170.05	185.350	-0.14/B	<<-
49	1 Apr 1981	B	5.460	1.152	194.00	223.490	-0.16/B	<<-
50	12 Apr 1981	B	6.050	1.167	212.19	247.620	0.08/B	->
51	15 Apr 1981	B	6.260	1.238	224.67	278.140	-0.14/B	<<-
52	8 May 1981	B	7.510	1.244	289.34	359.940	0.04/B	->
53	17 Jun 1981	B	2.500	0.811	62.85	50.970	-0.01/B	-
54	20 Jun 1981	B	2.260	0.535	69.18	37.010	0.11/B	->
55	9 Jul 1981	B	1.860	0.339	49.73	16.860	0.33/B	->>>>
56	28 Aug 1981	B	4.380	0.975	141.64	138.100	0.12/B	->
57	30 Aug 1981	B	4.400	0.987	144.54	142.660	0.06/B	->
58	13 Oct 1981	B	6.550	1.115	258.05	287.730	0.02/B	->
59	23 Nov 1981	B	2.070	0.841	47.94	40.320	-0.17/B	<<-
60	16 Dec 1981	B	1.470	0.458	33.32	15.260	-0.00/B	-
61	15 Feb 1982	B	1.140	0.451	20.27	9.140	-0.09/B	<-
62	21 Mar 1984	C	1.130	0.462	24.33	11.240	-0.19/B	<<-
63	27 Jun 1984	C	1.850	0.861	43.33	37.310	-0.31/B	<<<-

Total number of gaugings available = 63

Note : A comparison is made if a rating exists for the date of the discharge measurement (dm) and the stage of the dm is within the rating range.

Diff. = Difference in metres between dm and rating
Rat. = Rating used in comparison
Plot = Plot of Diff. to help determine shift point

ih

Table 5

Rating table for station 1 : H-117 - Sovani creek/Nasarowaqa

Rating A from 1 Jul 1974 Q = 5.305 (h - 0.280) ** 2.728 to 4.00 m

Stage (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0										
0.1										
0.2										0.00
0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
0.4	0.02	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08
0.5	0.09	0.10	0.11	0.12	0.13	0.15	0.16	0.18	0.20	0.22
0.6	0.24	0.26	0.28	0.30	0.33	0.35	0.38	0.41	0.44	0.47
0.7	0.50	0.53	0.56	0.60	0.64	0.68	0.72	0.76	0.80	0.85
0.8	0.89	0.94	0.99	1.04	1.09	1.14	1.20	1.26	1.32	1.38
0.9	1.44	1.50	1.57	1.64	1.71	1.78	1.85	1.93	2.00	2.08
1.0	2.17	2.25	2.33	2.42	2.51	2.60	2.69	2.79	2.89	2.99
1.1	3.09	3.19	3.30	3.41	3.52	3.63	3.74	3.86	3.98	4.10
1.2	4.23	4.35	4.48	4.61	4.75	4.88	5.02	5.16	5.31	5.45
1.3	5.60	5.75	5.90	6.06	6.22	6.38	6.54	6.71	6.88	7.05
1.4	7.23	7.40	7.58	7.77	7.95	8.14	8.33	8.53	8.72	8.92
1.5	9.13	9.33	9.54	9.75	9.97	10.18	10.40	10.63	10.85	11.08
1.6	11.31	11.55	11.79	12.03	12.27	12.52	12.77	13.03	13.28	13.54
1.7	13.81	14.08	14.35	14.62	14.90	15.18	15.46	15.75	16.04	16.33
1.8	16.63	16.93	17.23	17.54	17.85	18.16	18.48	18.80	19.12	19.45
1.9	19.78	20.12	20.45	20.80	21.14	21.49	21.84	22.20	22.56	22.93

Flows in cubic metres per second

Table 6

Summary of monthly data - Flow

Station number : 103 Name : Bandama a Bada

Basin no. : 1 Latitude : 8: 7:17 N Longitude : 5:31:31 W Altitude : 210.0
Area : 24050.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Mean
1962	-	-	-	-	4.89	8.03	21.6	114.	538.	419.	129.	49.1	-
1963	18.4	11.3	9.69	3.85	11.3	35.1	112.	286.	617.	589.	274.	60.4	170.
1964	26.6	11.8	5.09e	5.95	17.3	37.0	46.8	435.	-	-	174.	128.	-
1965	68.2	35.6	16.6	13.5	10.9	58.6	223.	442.	-	-	154.	54.8	-
1966	26.9	13.2	8.38	16.1	16.2	30.3	35.5	231.	455.	450.	162.	58.2	126.
1967	22.6	15.3	11.7	7.83	14.0	14.4	-	-	592.	425.	93.8	36.4	-
1968	15.6	13.0	6.81	7.80	22.4	28.8	122.	326.	529.	464.	152.	52.1	145.
1969	-	-	11.0	6.27	3.29	3.93	88.6	222.	402.	376.	335.	72.7	-
1970	28.8	14.0e	6.84	5.57	6.38	9.92	31.2	375.	-	-	-	-	-
1971	15.5	7.58	6.62	-	-	-	9.88	184.	444.	278.	-	-	-
1972	11.6	3.91	1.81	5.02	13.7	86.0	48.7	117.	139.	85.4	35.0	9.88	46.4
1973	6.53	1.82	0.359	1.60	3.90	3.06	-	-	332.	155.	49.4	10.3	-
1974	2.92	0.726	0.078e	0.553e	3.59e	3.98	11.7e	211.e	442.	302.	83.0	12.7	89.8
1975	7.67	3.18e	1.22e	0.983	6.29	7.51e	24.3e	200.	526.	199.e	60.2	-	-
1976	6.68	3.15	2.50	1.89	2.26	6.86	23.8	9.21	6.30	91.5	103.	15.9	21.9
1977	5.74	1.97	0.306	-	-	-	-	-	-	-	-	-	-
1978	0.758	3.124	0.327	1.77	8.69	-	-	-	-	-	-	-	-
1979	1.15	0.102	0.0	0.0	4.72	27.7	148.	343.	801.	323.	56.2	15.5	144.
1980	-	-	-	3.89e	10.2	20.4	42.9	180.	566.	272.e	-	-	-
1981	-	-	-	-	-	20.6e	55.7	249.	234.	120.	-	-	-
1982	-	-	1.15e	8.97e	6.94e	5.54e	17.1e	33.5e	118.e	56.6e	37.3e	6.69e	-
1983	1.24	0.544	0.813	1.36	3.24	3.44	6.83e	9.64	26.9	16.0	1.51	0.930	6.06
1984	0.0	0.0	0.418	0.110	7.10	10.8	23.9	57.4	147.	83.9	21.7	5.44	29.8
1985	1.95	0.215	1.94	7.43	4.80	6.42	51.8	468.	546.	139.	33.7	6.32e	106.
Mean	14.1	7.24	4.44	5.02	8.66	20.4	57.3	225.	393.	254.	108.	35.0	98.5
Std	16.3	8.86	4.80	4.41	5.45	20.9	55.5	143.	222.	167.	89.8	33.8	
CV	1.15	1.22	1.08	0.877	0.630	1.03	0.969	0.636	0.566	0.656	0.835	0.965	

Mean monthly flow in cubic metres per second

Data flags

Missing - flag "-" Original - no flag Estimate - flag "e"

Limit to missing daily data permissible [2]

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Table 7

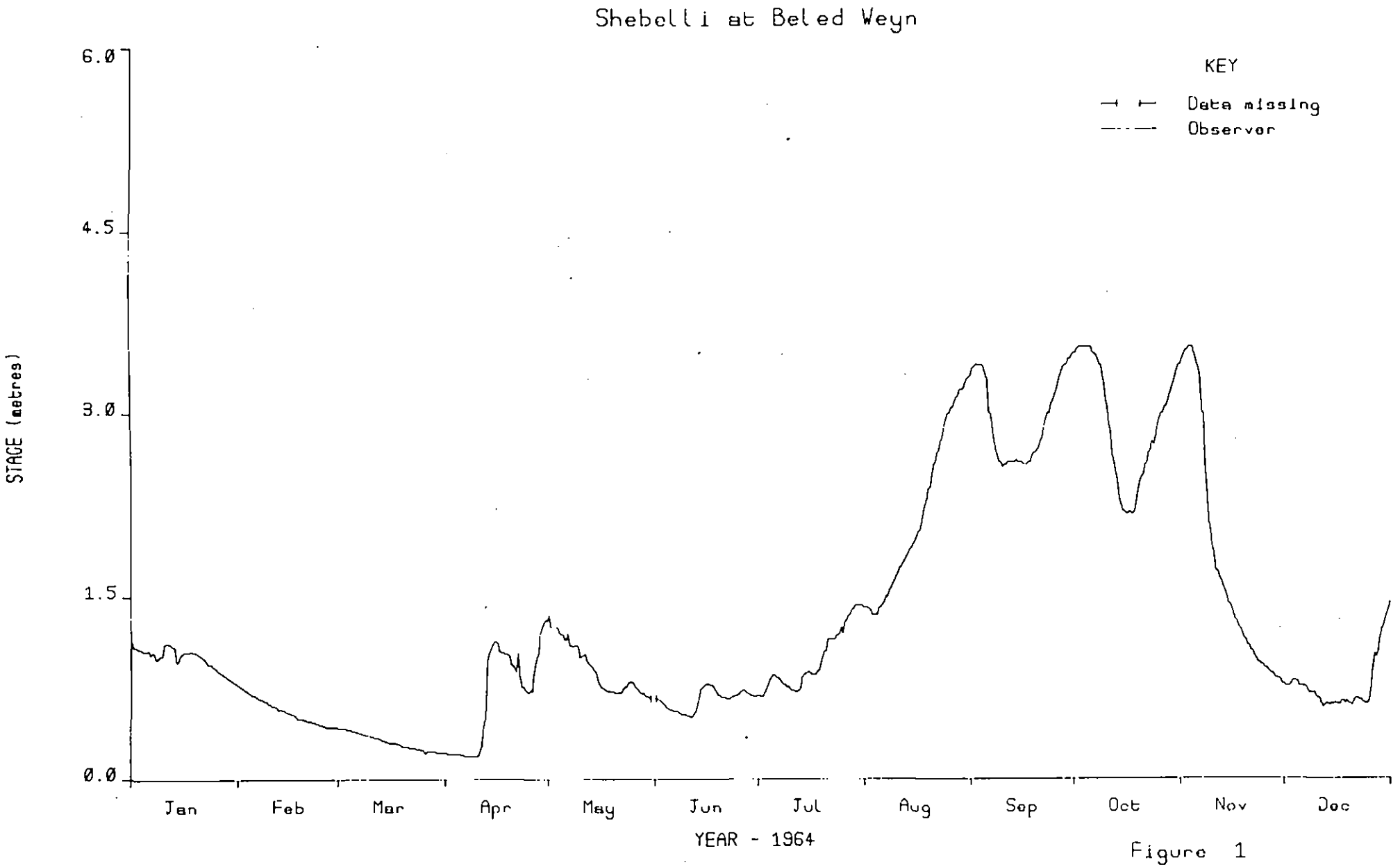
Shebelli at Beled Weyn
KEY
Data missing
Observer
6.0
4.5
3.0
1.5
0.0
STAGE (metres)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
YEAR - 1964

Figure 1

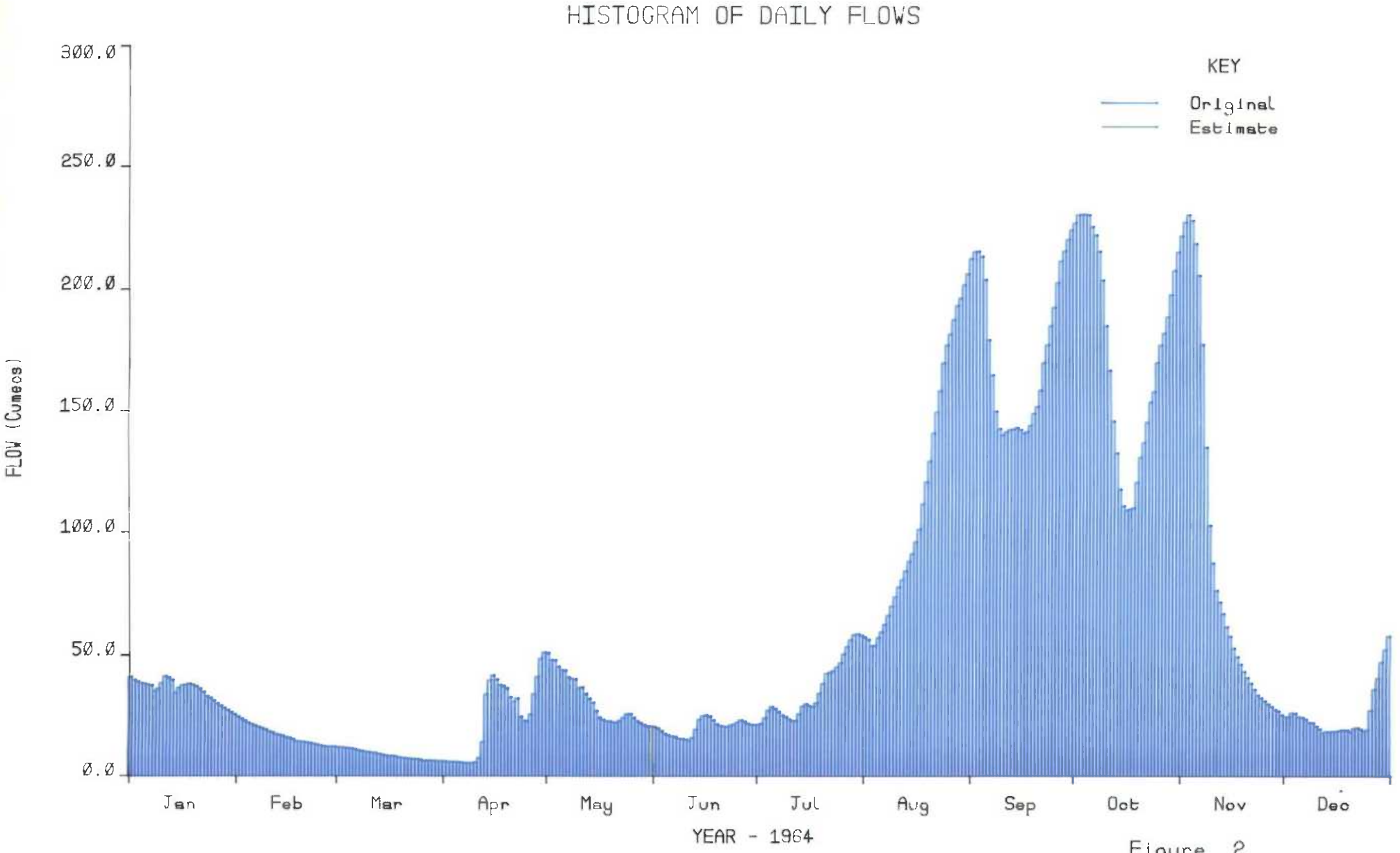
HISTOGRAM OF DAILY FLOWS
KEY
Original
Estimate
300.0
250.0
200.0
150.0
100.0
50.0
0.0
FLOW (Cumecs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
YEAR - 1964

Figure 2

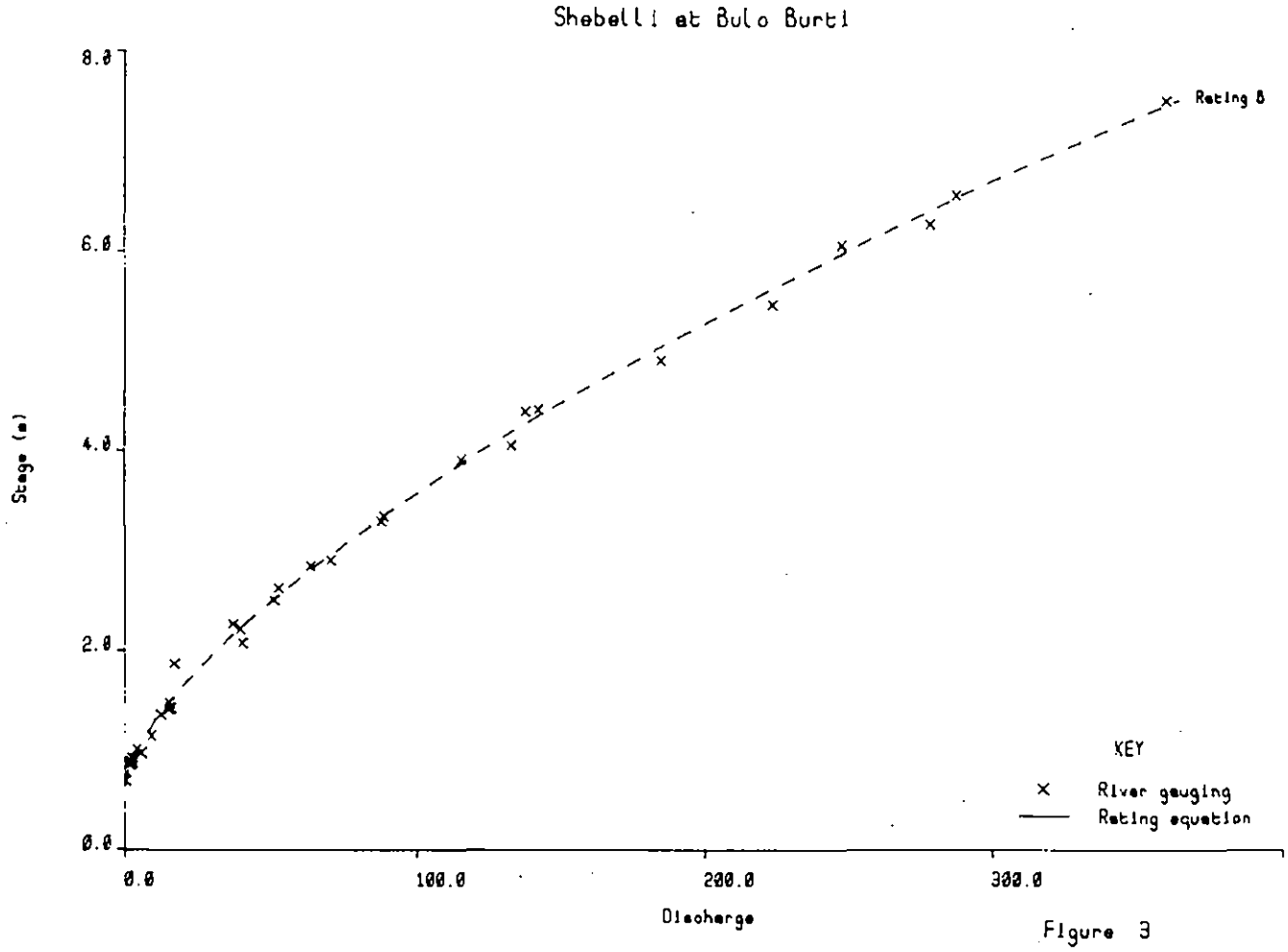

Figure 3

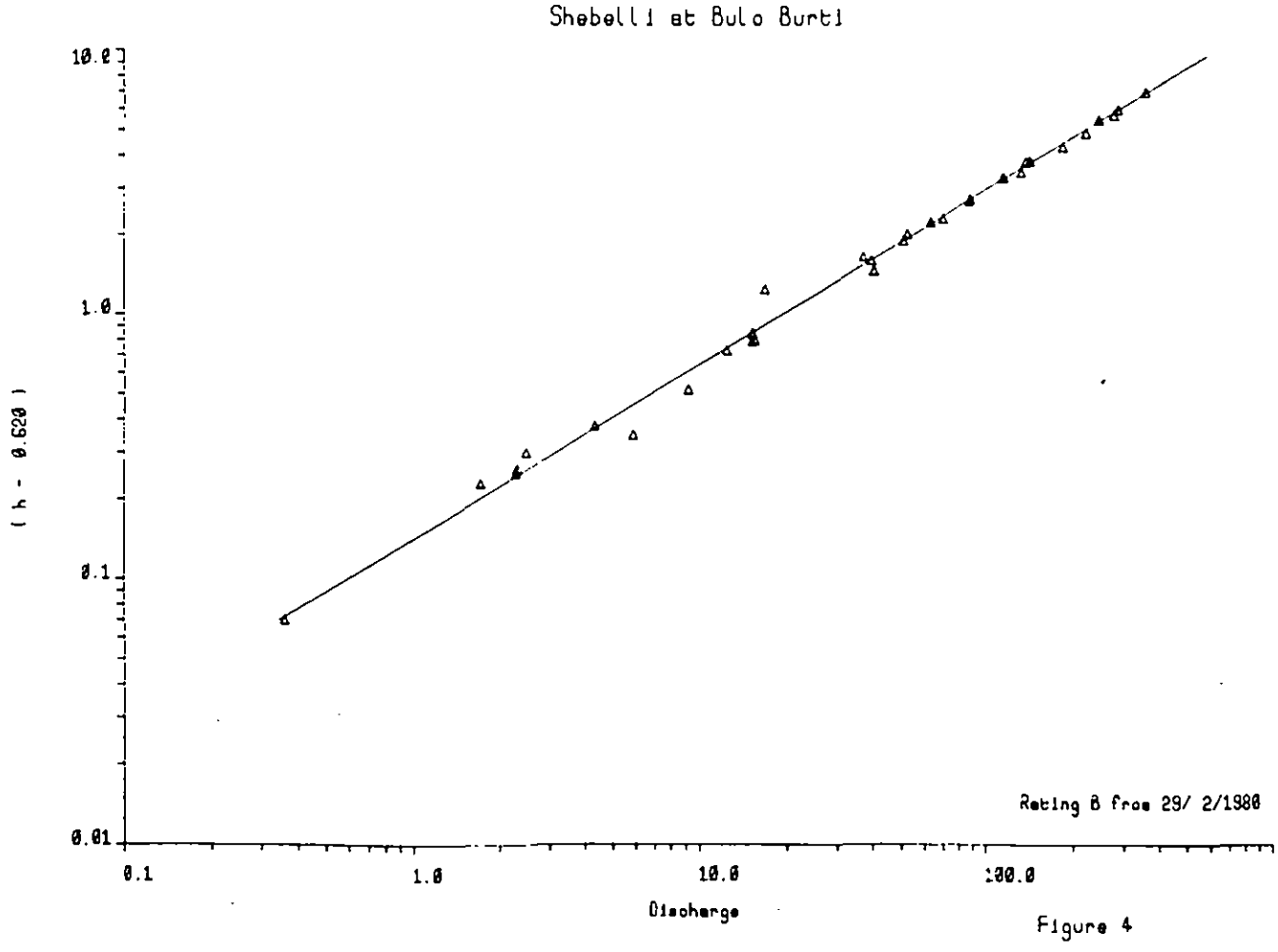

Figure 4

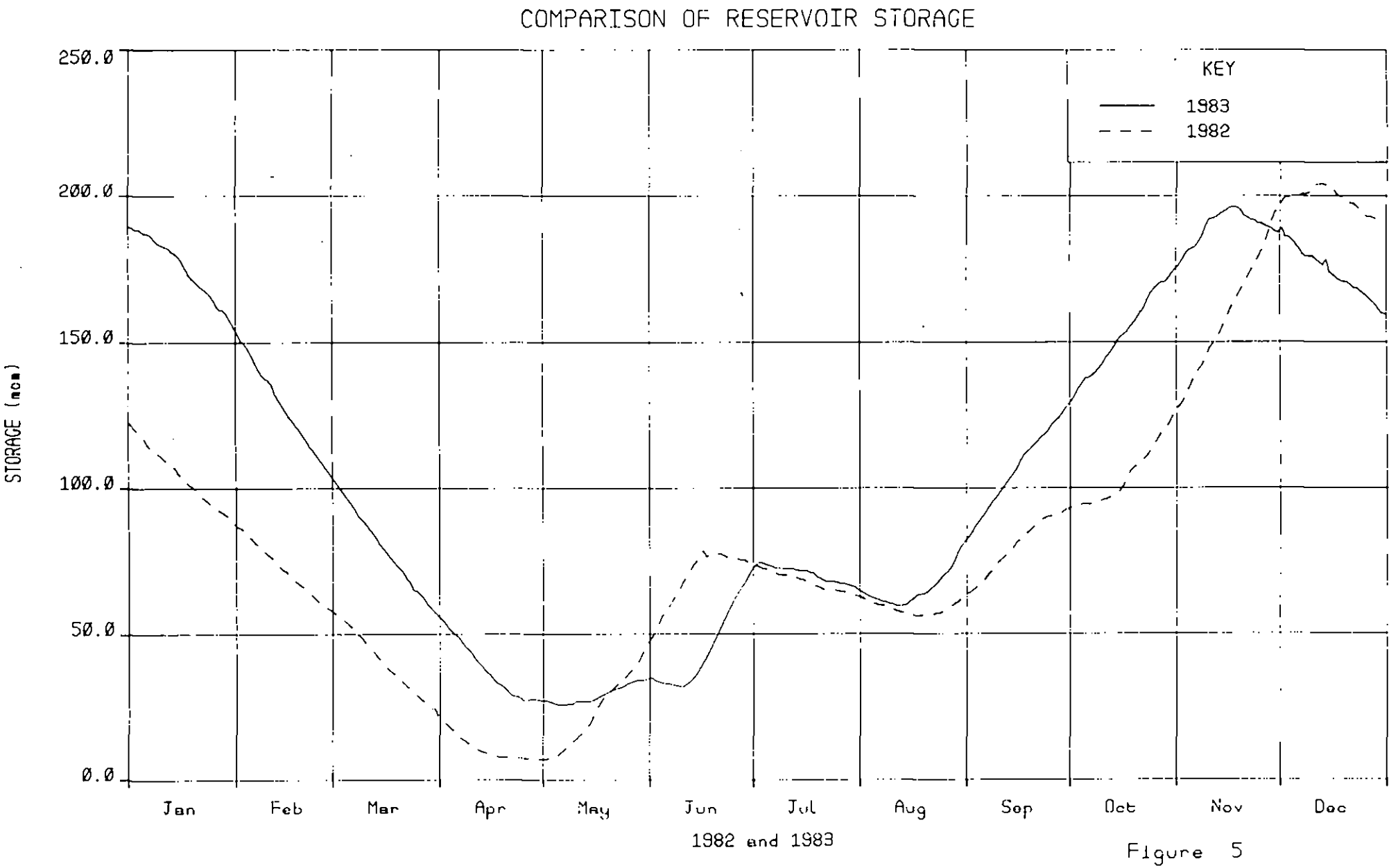
COMPARISON OF RESERVOIR STORAGE
KEY
1983
1982
250.0
200.0
150.0
100.0
50.0
0.0
STORAGE (mcm)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1982 and 1983

Figure 5

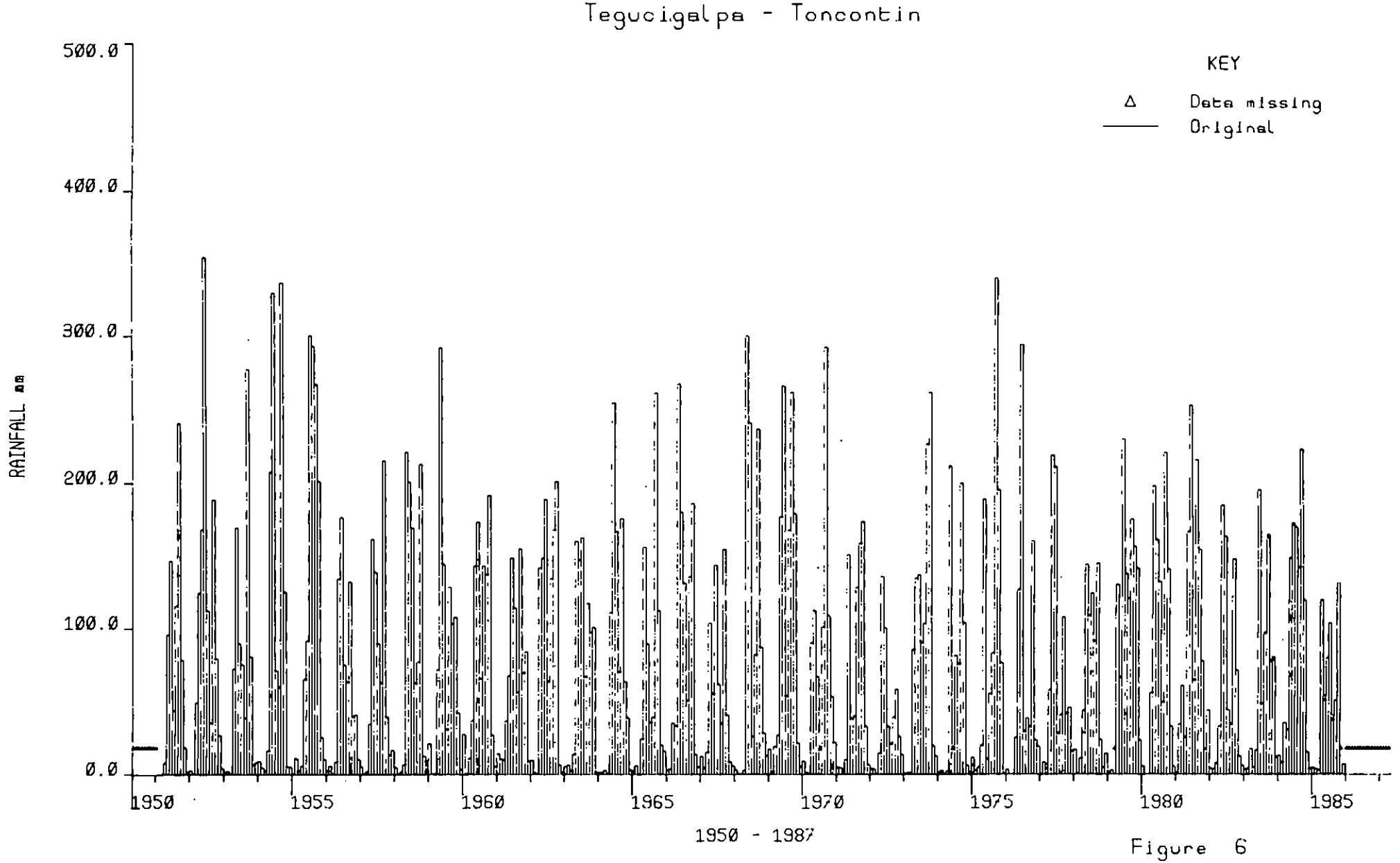
Tegucigalpa - Toncontin
KEY
Δ Data missing
Original
RAINFALL mm
500.0
400.0
300.0
200.0
100.0
0.0
1950
1955
1960
1965
1970
1975
1980
1985
1950 - 1987

Figure 6

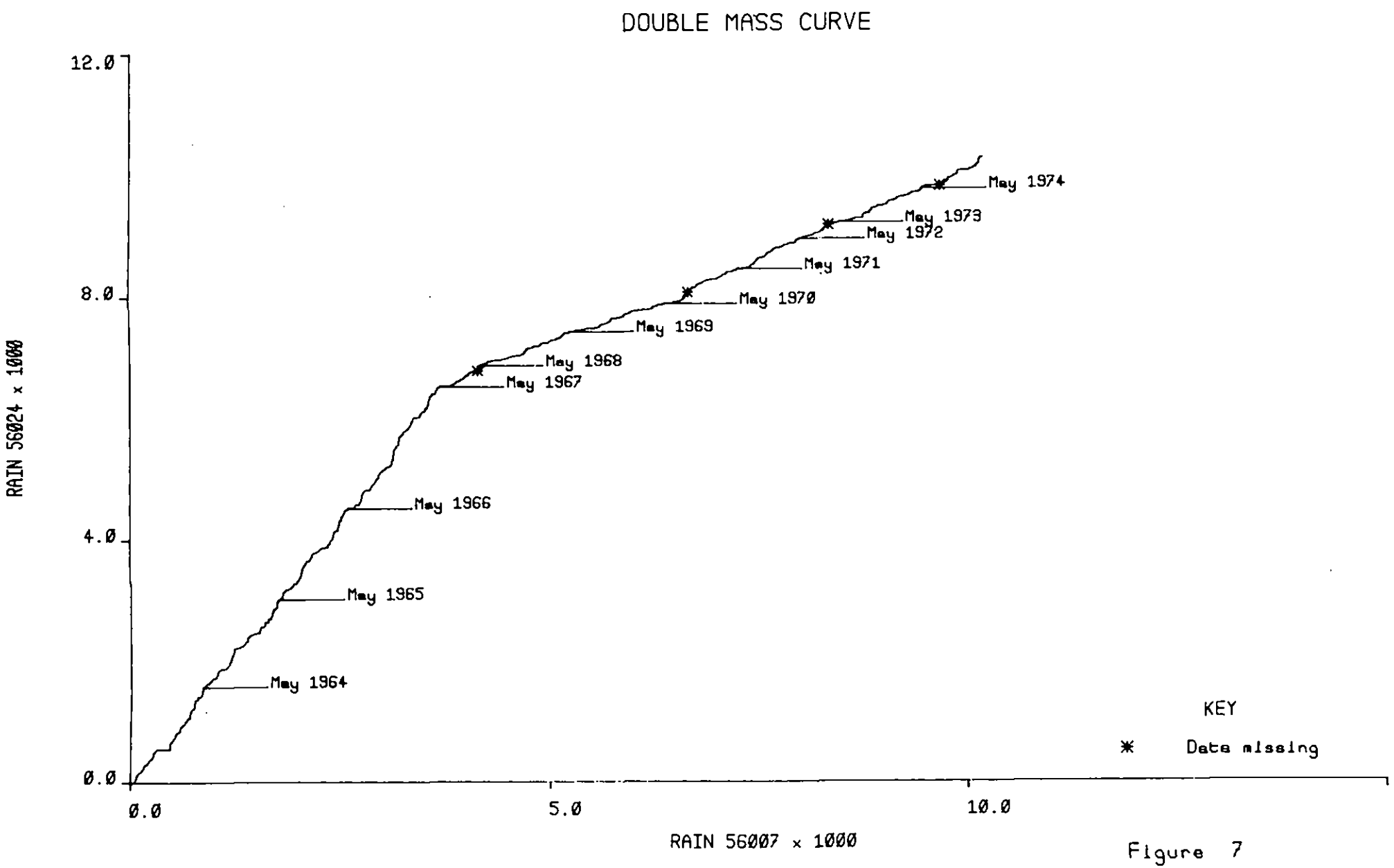
DOUBLE MASS CURVE
12.0
8.0
4.0
0.0
RAIN 56024 x 1000
May 1974
May 1973
May 1972
May 1971
May 1970
May 1969
May 1968
May 1967
May 1966
May 1965
May 1964
KEY
Data missing
0.0
5.0
10.0
RAIN 56007 x 1000

Figure 7

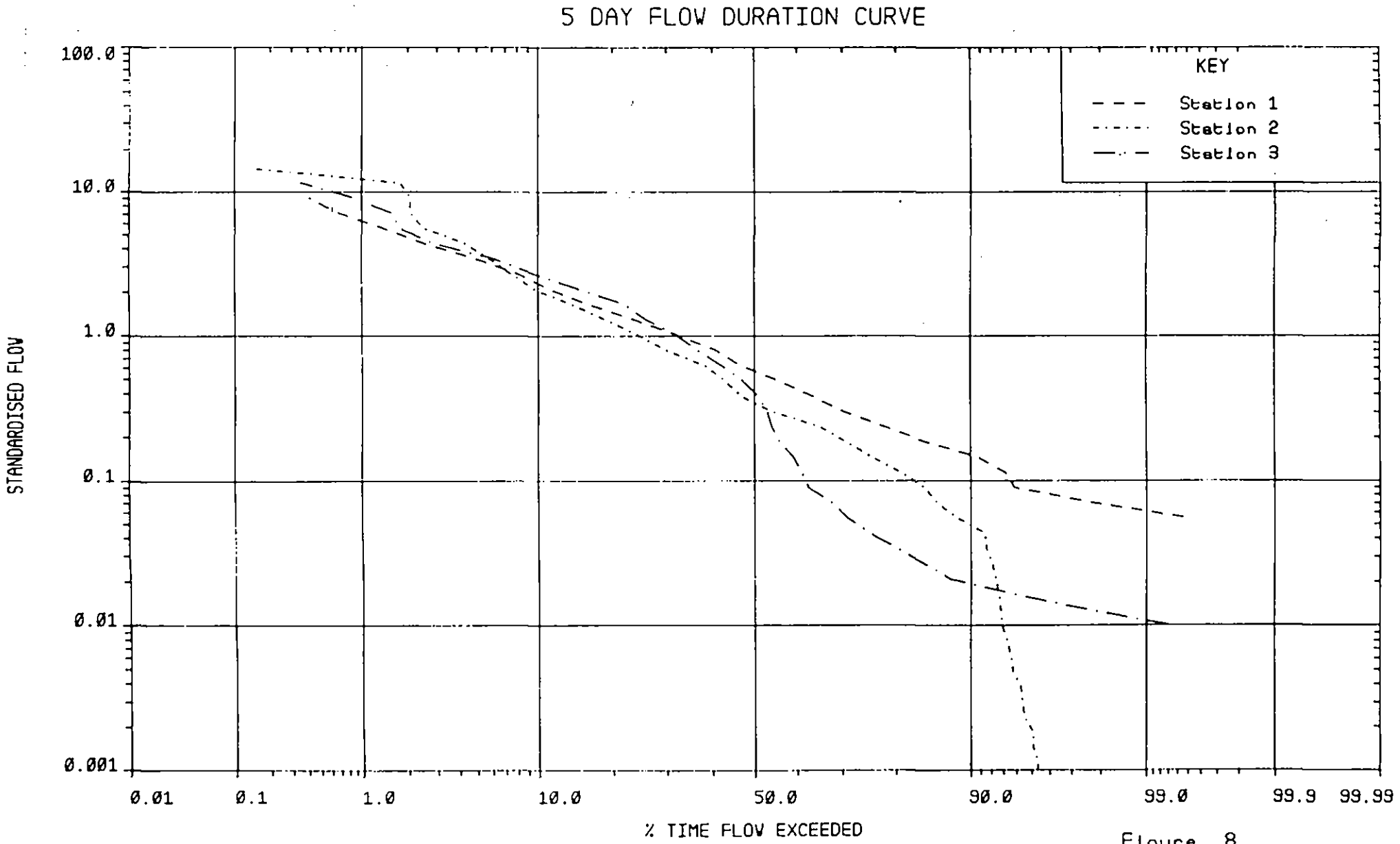
5 DAY FLOW DURATION CURVE
KEY
Station 1
Station 2
Station 3
100.0
10.0
1.0
0.1
0.01
0.001
STANDARDISED FLOW
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% TIME FLOW EXCEEDED

Figure 8

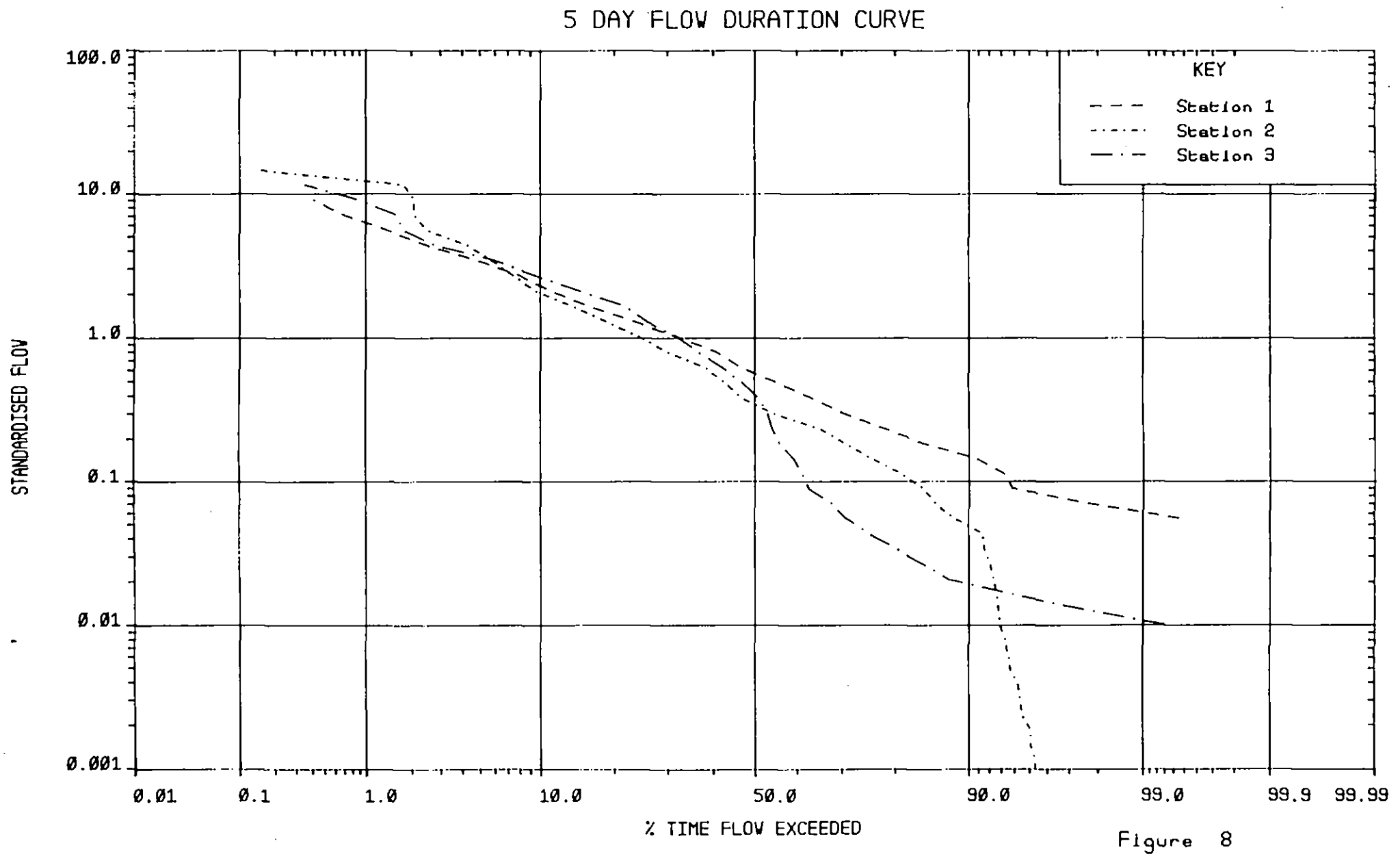
5 DAY FLOW DURATION CURVE
KEY
Station 1
Station 2
Station 3
100.0
10.0
1.0
0.1
0.01
0.001
STANDARDISED FLOW
0.01
0.1
1.0
10.0
50.0
90.0
99.0
99.9
99.99
% TIME FLOW EXCEEDED

Figure 8

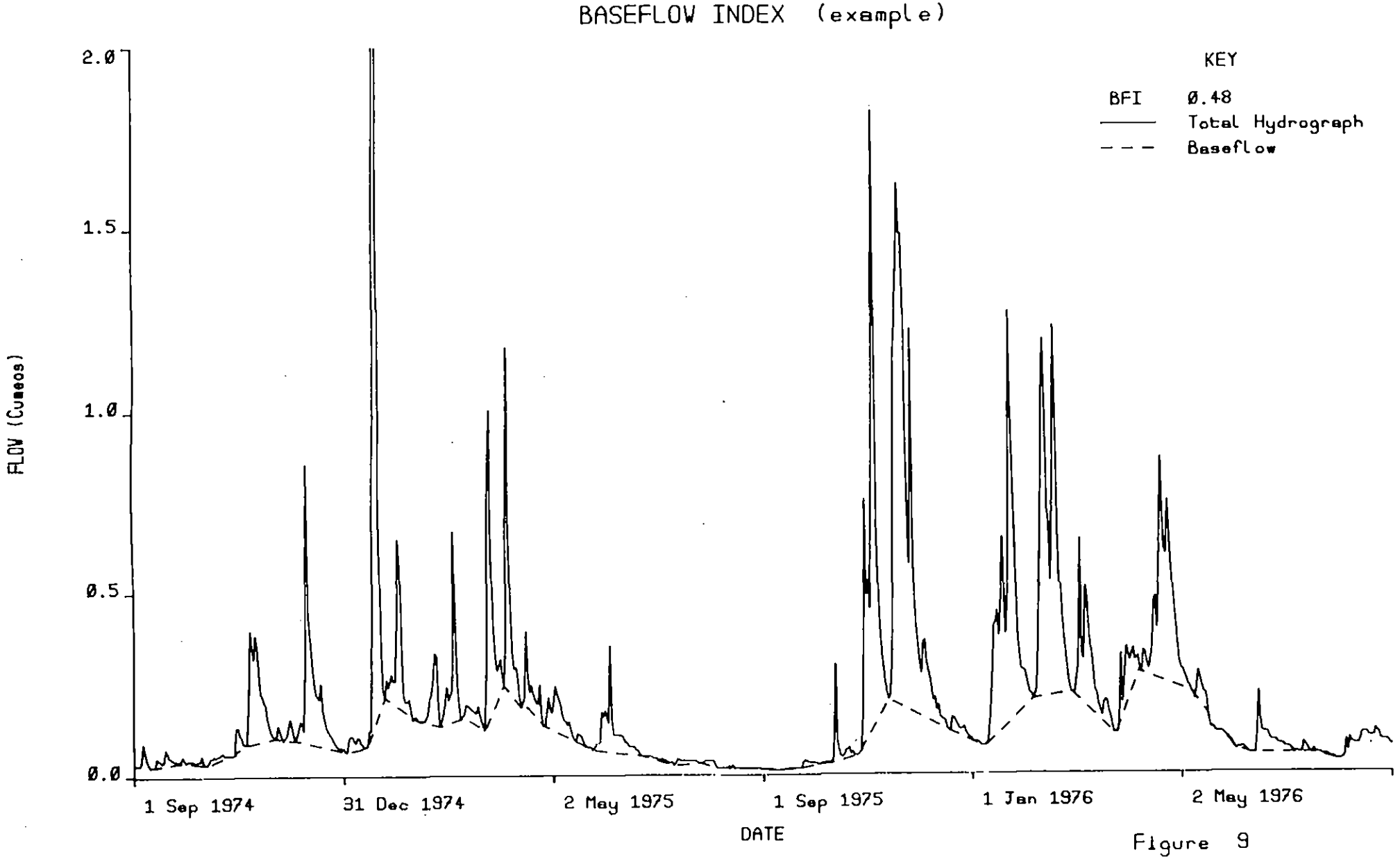
BASEFLOW INDEX (example)
KEY
BFI Ø.48
Total Hydrograph
Baseflow
2.Ø
1.5
1.Ø
Ø.5
Ø.Ø
FLOW (Cusecs)
1 Sep 1974
31 Dec 1974
2 May 1975
1 Sep 1975
1 Jan 1976
2 May 1976
DATE

Figure 9